Inquiry and Investigation
Lesson Plan

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Course Name Earth Systems

Core Curriculum Standard Fulfilled: Standard V: Students will understand that Earth's atmosphere interacts with and is altered by the lithosphere, hydrosphere, and biosphere.

Core Curriculum Objective Fulfilled: Objective 2: Trace ways in which the atmosphere has been altered by living systems and has itself strongly affected living systems over the course of Earth's history.

Intended Learning Outcomes (ILOs) Fulfilled:

ILO **1. Use Science Process and Thinking Skills**

a. Observe objects, events and patterns and record both qualitative and quantitative information.
b. Use comparisons to help understand observations and phenomena.
c. Plan and conduct experiments in which students may:
   - Identify a problem.
   - Formulate research questions and hypotheses.
   - Predict results of investigations based upon prior data.
   - Plan procedures to control independent variables.
   - Collect data on the dependent variable(s).
   - Select the appropriate format (e.g., graph, chart, diagram) and use it to summarize the data obtained.
   - Analyze data, check it for accuracy and construct reasonable conclusions.
   - Prepare written and oral reports of investigations.
d. Construct models, simulations and metaphors to describe and explain natural phenomena.
e. Use mathematics as a precise method for showing relationships.

ILO **3. Demonstrate Understanding of Science Concepts, Principles and Systems**

a. Know and explain science information specified for the subject being studied.

ILO **4. Communicate Effectively Using Science Language and Reasoning**

a. Provide relevant data to support their inferences and conclusions.
b. Use precise scientific language in oral and written communication.
c. Use mathematical language and reasoning to communicate information.

Time Needed To Complete Inquiry: 50-70 minutes

Inquiry: What is the research question to be scientifically investigated and how will your students actively participate? Students will investigate the question: How does the surface of Earth affect the amount of heat the suns rays create?

How will you use Guided Inquiry, Semi-guided Inquiry, or Open Inquiry as your teaching method? Students design two containers with surface materials and shine a light on them. Both containers will have the same materials in the bottom and one will be covered with a plastic wrap "atmosphere". They will record the temperature reached in the containers.

Assessment: How will you know that your students have met the objective? Are there application extensions to this activity, interpretative test items, etc.? Students will share data and create graphs to analyze data. They will explain to the class their findings.

Prior Knowledge Needed: What background knowledge and skills do the students need to be prepared for this inquiry? Students should know that sunlight absorbed by Earth's surface changes to heat. They will discuss it before the lab as they read the introduction.

Introduction: Global warming is a "hot" topic right now and students may have heard that Earth is warming up. The introduction of the student lab provides some examples to discuss with students.

Materials / Resources Needed for the Investigation: See below.

Procedures of the Investigation: Describe the actual investigation. What will the students do? If applicable, identify the independent and dependent variables, the constants, and the repeated trials. See below

Data Collection: How will students collect and organize data (tabulation)? See below

Data Analysis: How will students be able to interpret the data (e.g., graphs), to reach consensus (if appropriate)? How will they draw conclusions? See below

Closure: How will you provide closure to the experience? How will students effectively communicate what they learned? See below:

Earth Systems
Standard V, Objective 2

Title: Greenhouse Effect and Surface Radiation

Description: Students will design a controlled experiment to demonstrate the greenhouse effect and the effect of different surfaces on light reflection.

Materials: 2 large beakers per group, source of carbon dioxide (dry ice, car exhaust, vinegar and baking soda), thermometers or Intel temperature probes (2 per student group) different substances for the bottom of the beakers such as dirt, water, white paper, snow, black paper, grass or leaves, rocks etc., light sources (4-5 per classroom) student page (see below)

Time Needed: 70 minutes

Background Knowledge: The plastic wrap used in this experiment to model the action of greenhouse gases is limited. It should be explained to students that individual molecules of $C0_2$, methane and water vapor act to reflect heat back to Earth instead of allowing it to immediately radiate back out into space. The plastic wrap, being a solid is a poor model but effective for this experiment. Students should be able to read a thermometer or use their Intel probe.

Procedures:

Day 1 (20 minutes)

1. Read the introduction on the student page with students. Show students the materials and read the procedures with them. Have students look carefully at the drawings.
2. Remind student that the reason for the control is to have a way to compare their test results.
3. Give students time to work in their groups and decide on what substance they want to place in the bottom of their beakers. Have a group member come to the board and write the groups' choice on it. No two groups can have the same one.
4. Groups may chose to place substances in their beaker that you do not provide. Give them the opportunity to bring them in for the experiment on day 2.
5. Have students write a hypothesis based on the list of substances on the board. Have them predict which beaker will heat the most and the least.

Day 2 (50 minutes)

1. Have students begin their experiment and place it under the light source. Remind them to keep the beakers about 30 cm from the light.
2. Allow 12 minutes for students to gather and record data.
3. Have students report to the class by group with their findings. Record their findings on the board or an overhead as they present them. Ex.:

Surface	Beaker A(no plastic wrap)	Beaker B (with plastic wrap)	Difference (B-A=)
Water			
Dirt			

4. Have each group explain why they think they got their results.

Scoring Guide

1. Student participates and contributes to activity……4
2. Student collects data and graphs accurately……4
3. Student correctly answers analysis questions……..4

Name_____

Title: Greenhouse Effect And Surface Radiation

Introduction: The sun sends Earth radiation in the form of light every day. As it passes through the atmosphere it does not react with the molecules in the air. Light must first strike the surface and change to heat waves. Some surfaces change light to heat very effectively. You may have experienced this phenomenon in the summer as you attempted to walk barefoot across an asphalt road on a sunny day. Dark asphalt gets very hot! Lighter colored cement is much cooler. As the heat waves enter the air, molecules of water, methane and CO_2 have the ability to slow down heat waves that might escape and reflects them back to Earth. Because of this property, Earth's atmosphere wraps us like a warm blanket. In this experiment you will individually test 2 beakers for the greenhouse effect and as a class, compare surfaces.

Materials:
2 large beakers, a substance to place in the beakers (water, sawdust, leaves, dirt, white paper, black paper, aluminum foil, styrofoam, cardboard, carbon dioxide), two thermometers or Intel probes, masking tape, ruler

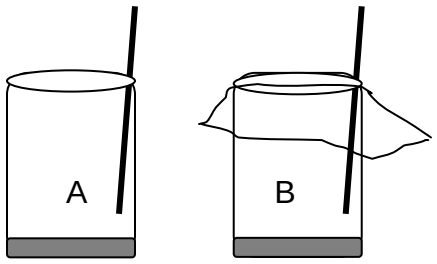
Hypothesis: (Which substances do you predict will have the highest and lowest temperatures at the end of the experiment?)

Identify:

Independent Variables:

Dependent Variable:

Procedures:



1. Get your beakers and place your substance on the bottom of them. You should only have thin layer of the substance. Label the beakers A and B. Beaker B will have plastic wrap over the top.
2. Tape your thermometer so that it doesn't touch the bottom or sides of the beaker.
3. Place your beakers 30 cm from the light source.
4. Take readings of the temperatures for 10 minutes.

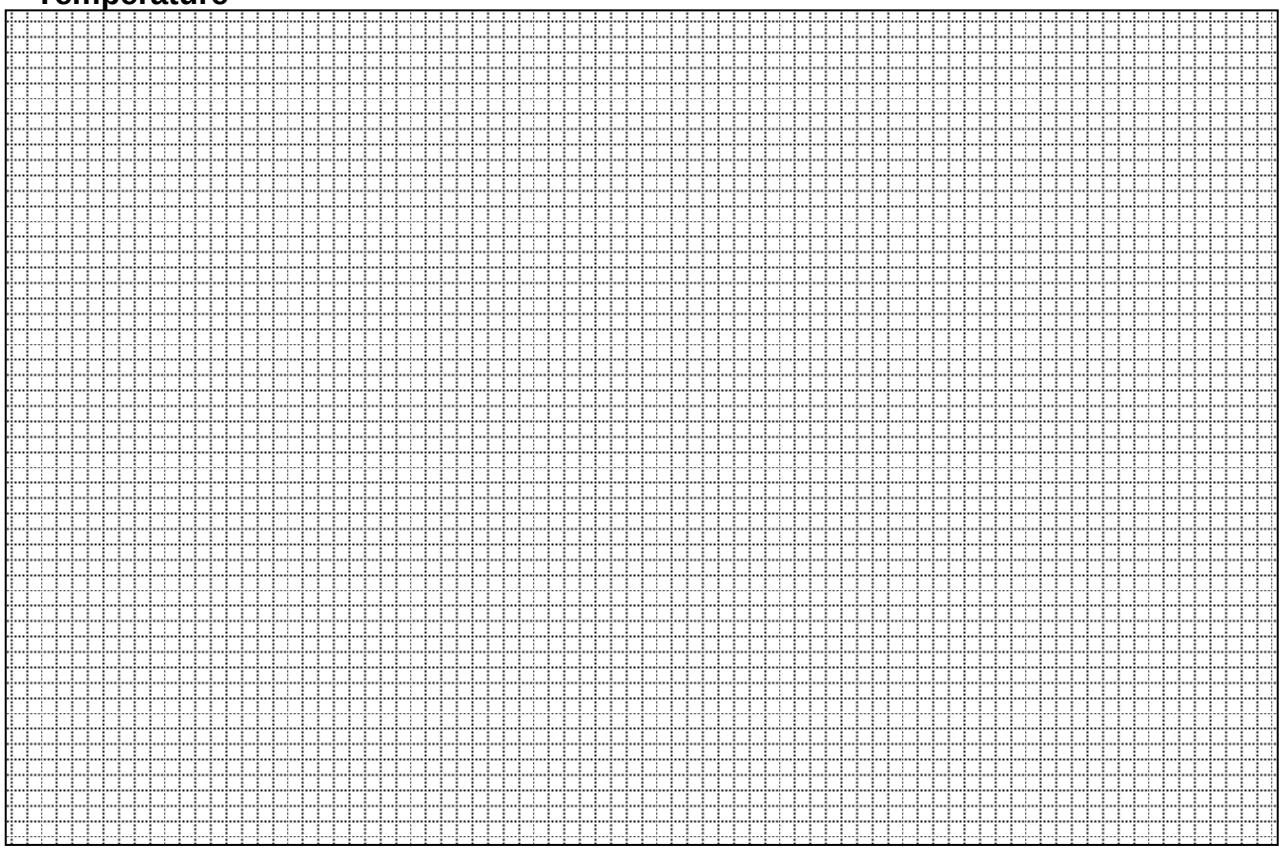
5. Graph your results.
6. Report to the class your highest readings for both beakers and the difference between them. Be prepared to explain why you think your beaker responded the way it did.
7. Clean up as directed.

Data:

Temperature

Time	Beaker A	Beaker B
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Temperature



Time

Analysis:

1. Which of your beakers had the highest temperature? Why do you think this was so?

2. Which beaker in the class had the highest temperature? Why do you think this was so?

3. Which beaker in the class had the lowest temperature? Why do you think this was so?

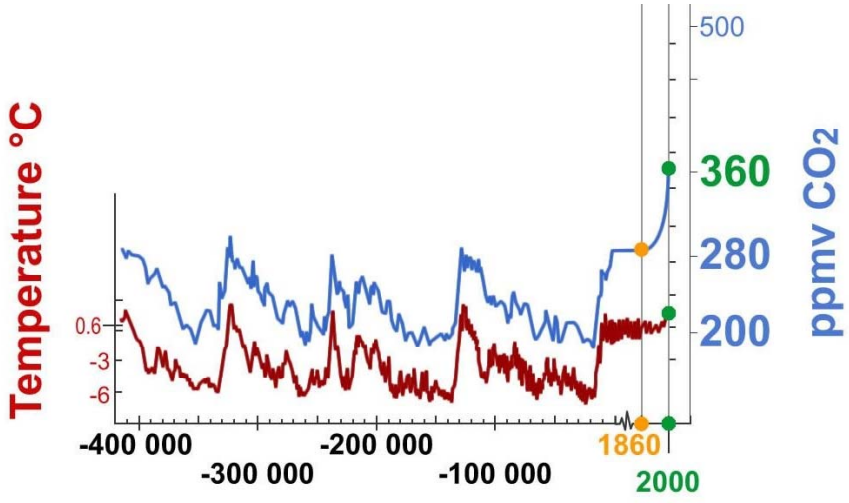
4. Venus has an atmosphere with much more CO_2 than Earth. What would you predict about temperatures on Venus?

5. Mars has an atmosphere with less CO_2 than Earth. What would you predict about temperatures on Mars?

6. What factors influence the temperature of air?

7. Scientists hypothesize that human activities are adding greenhouse gases to Earth's atmosphere that will increase Earth's temperatures. What evidence from this experiment supports this hypothesis?

8. The graph shows the relationship between CO_2 and temperature. What are three inferences you can make from this information?



9. Based on the graph, how many degrees of temperature make the difference between an ice age (the coldest temperatures) and today's temperatures?

Conclusion: